#2772

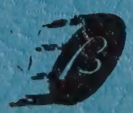
INSTRUCTION MANUAL FOR

MODEL #202 #2772

0-30 KV DC POWER SUPPLY

Models: 201-206

SERIAL #199



BETA ELECTRIC CORP.

NEW YORK, N. Y.

#2772

PLEASE NOTE:

Read the entire instruction manual thoroughly before attempting to operate the power supply.

If this is not convenient, please read the operating instructions completely before applying power for the first time.

#2772

OPERATING INSTRUCTIONS

for

SERIES 201

PORTABLE HIGH VOLTAGE POWER SUPPLIES

0 to 30 KV DC

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Models 201, 202, 203, 204, 205 and 206

OPERATING INSTRUCTIONS

for

SERIES 201

PORTABLE HIGH VOLTAGE POWER SUPPLIES

0 to 30 KV DC

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Models 201, 202, 203, 204, 205 and 206

SPECIFICATIONS

for Models 201, 202, 203, 204, 205 and 206

Portable 0-30 KV DC Power Supplies

INPUT:	100-130 volts, 50/60 cycles, 220 volt-amperes, maximum. (117 volts nominal)
OUTPUT:	
Voltage:	Continuously variable from 0 to 30 KV DC
Current:	2 milliamperes Maximum (determined by rectifier rating) Models 201, 202, and 203-Approximately 400 microamperes at 30 KV. Models 204, 205 and 206-Approximately 1.8 milliamperes at 30 KV
Polarity:	Models 201, 204-High Voltage positive (negative grounded) Models 202, 205-High voltage negative (positive grounded) Models 203, 206-Reversible High Voltage polarity (low grounded)
Regulation:	Internal resistance of approximately 3 megohms. (Not stabilized against line voltage variations)
Ripple:	0.3% with external load of 1000 megohms. 0.6% with external load of 100 megohms. 3% with external load of 10 megohms. 25% with external load of 1 megohms.
CONTROLS:	(1) FILAMENTS ON toggle switch. (2) HIGH VOLTAGE HOLD pushbutton. (3) HIGH VOLTAGE LOCK pushbutton. (4) HIGH VOLTAGE OFF pushbutton. (5) Output voltage control covat*. (6) (Models 203 and 206 only) Output voltage meter polarity reversing switch.
METERS:	0-30 KILOVOLTS DC, 2-1/2" case; output voltage. Initial accuracy 2.5%. 0-2 amperes AC, 2-1/2" case, covat current
FUSE PROTECTION:	2 amperes.
SIZE:	16" x 16" x 8".
WEIGHT:	35 pounds.

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COVAT* - COntinuously Variable Auto-Transformer, i.e. "Variac", "Powerstat", etc.

SPECIFICATIONS

for Models 201, 202, 203, 204, 205 and 206

Portable 0-30 KV DC Power Supplies

INPUT: 100-130 volts, 50/60 cycles, 250 watts-ampere, maximum. (117 volts nominal)

OUTPUT:

Voltage: Continuously variable from 0 to 30 KV DC

Current: 2 milliamperes Maximum (determined by rectifier rating)
Models 201, 202, and 203-Approximately 100 microamperes at 30 KV.
Models 201, 205 and 206-Approximately 1.8 milliamperes at 30 KV

Polarity: Models 201, 204-High Voltage positive (negative grounded)
Models 202, 203-High voltage negative (positive grounded)
Models 205, 206-Reversible High Voltage polarity (low grounded)

Regulation: Internal resistance of approximately 3 megohms. (Not stabilized against line voltage variations)

Ripple: 0.5% with external load of 1000 megohms.
0.05% with external load of 100 megohms.
5% with external load of 10 megohms.
25% with external load of 1 megohms.

CONTROLS: (1) FILAMENTS ON toggle switch.
(2) HIGH VOLTAGE HOLD pushbutton.
(3) HIGH VOLTAGE LOCK pushbutton.
(4) HIGH VOLTAGE OFF pushbutton.
(5) Output voltage control cover*.
(6) (Models 205 and 206 only) Output voltage meter polarity reversing switch.

METERS: 0-30 KILOVOLTS DC, 2-1/2" case; output voltage. Initial accuracy 2.5%.
0-2 amperes AC, 2-1/2" case, coval current

FUSE PROTECTION: 2 amperes.

SIZE: 16" x 16" x 8".

WEIGHT: 35 pounds.

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GENERAL:

The Beta Electric Corp. Series 201 Portable 0 to 30 KV DC Power Supplies, utilizing rectified 60 cycle power, are particularly suitable for low current, high voltage applications. Approximately 400 microamperes may be drawn at 30 KV, from Models 201, 202, and 203 power supplies, and 1.8 MA at 30 KV in the 204, 205, and 206 models.

The maximum permissible drain is limited by the rectifiers' rating to 2 milliamperes average, and is available below approximately 24 KV in the Models 201, 202 and 203, and approximately 28 KV in the Models 204, 205, and 206.

These Power Supplies employ a full-wave voltage doubler circuit, permitting the use of components considerable lower in voltage rating than required in a full-wave or half-wave single stage rectifier of equivalent output. The high voltage transformer is rated at 11.5 KV rms, and the rectifiers are subjected to an inverse voltage approximately equal to the actual output voltage. Thus, with rectifiers rated at 40 to 60 KV inverse, there is an ample margin of safety at an output voltage of 30 KV. (40 KV rating in Models 201, 202 and 203; 60 KV rating in Models 204, 205 and 206.)

The high voltage filter capacitors contain plastic dielectric materials of high breakdown rating, reducing the size and weight considerably over capacitors of the same rating utilizing paper or similar dielectric materials.

A unique filement transformer design, developed by the Beta Electric Corp., results in a lightweight, air-insulated unit with filament windings rated for more than 30 KV DC insulation with respect to the core and to the other windings. Without this lightweight, multi-winding high voltage filament transformer, a portable, rectified 60 cycle, 0 to 30 KV DC Power Supply would not be practical.

In the series 201 Power Supplies, the output DC voltage is metered, as is the covat* output current. This latter meter is valuable as a general trouble-shooting device. The ammeter will indicate whether there are any shorts in the Power Supply or in the load circuit, by reading off-scale with only a few volts output from the covat. The meter will read lower than normal in case of open circuit.

In the series 201-M power supplies, a load current meter is substituted for the covat current meter. The load current meter is at ground potential, indicating all leakage and corona current, as well as load currents.

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*See note, page 1

In the Models 203 and 206, the high voltage polarity with respect to the grounded case may be either positive or negative, as desired. Polarity reversal is effected by reversing the sense of rectification of the two rectifier tubes. In the Models 201 and 204, the high voltage DC polarity is fixed, positive with respect to the cabinet. In the Models 202 and 205, the high voltage polarity is fixed, negative with respect to the cabinet.

For added operating convenience, the control panel has been made removable from the high voltage circuits proper. The panel wiring is connected to the remainder of the circuits through a cable connector pair. When the panel is removed, it is merely necessary to run an extension cord of the desired length from the control panel to the high voltage circuits. The extension cord can be well over one hundred feet in length without affecting the operating properties of the Power Supply.

CIRCUIT DETAILS:

Referring to the accompanying schematic circuit drawing, the complete operation of the power supply can be understood.

S1 is a two-pronged recessed male connector, located on the left-hand side of the cabinet, as viewed from the front, through which the Power Supply is connected to the 117 volt mains, by means of a line cord (provided with the power supply).

S2 is an auxiliary 117 volt outlet, located adjacent to the input connector, that may be used for such equipment as an oscilloscope, soldering iron, etc. It can also be used for an external safety interlock, or for an external output shorting mechanism. (See Application Notes 3 and 4).

F is a fuse for general protection.

Switch SW1 energizes the filament transformer T2, and pilot light PL1 " FILAMENTS ON".

Depressing PB2, the pushbutton labelled "HIGH VOLTAGE HOLD", energizes the covat* T1 and, accordingly, the primary of the high voltage transformer T3. When PB2 is depressed, the "HIGH VOLTAGE ON" pilot light, PL2, is illuminated. When PB2 is released, the covat is de-energized.

If it is desired to have the high voltage continuously on, then, when PB2 is depressed, it is necessary to depress PB3, the pushbutton labelled "HIGH VOLTAGE LOCK". This energizes the relay RL, shorting out pushbuttons PB2 and PB3 by means of the two normally open contacts 1a and 1b on the relay RL. The relay is now held in automatically, and the pushbuttons may be released; the high voltage will remain on.

To de-energize the high voltage when it has been "locked in", the red pushbutton labelled "HIGH VOLTAGE OFF", PB1, must be depressed. This causes the relay to drop out, removing covat power.

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*See Note, Page 1

Capacitors C1 and C2 constitute a line filter to reduce feedback of rf-generated corona from the high voltage circuits to the power mains. Meter M1 monitors the input current to the high voltage transformer T3. In case of a short circuit in the high voltage components or load, M1 will read higher than normal. If a circuit element is open, M1 will read lower than normal. Normal reading is about 0.5 amperes at no load and 30 KV output.

The high voltage doubling circuit consists on transformer T3, capacitors C3a and C3b, and rectifiers VT1 and VT2, connected as a full-wave voltage doubler.

R1 is a protective resistor to limit the value of the initial surge of current in the output circuit, in case of arc-over or failure of a component subjected to the high voltage.

R2 acts as a bleeder across the high voltage capacitor, and as the voltmeter multiplier. Meter M2 serves as the output voltage indicating meter. R3 calibrates M2 for full-scale deflection with 30 KV DC output.

It should be noted that the output kilovoltmeter is connected directly at the output lead; therefore, no correction need be made to the kilovoltmeter reading for the IR drop across the protective resistor R1.

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(The remaining circuit details apply only to Models 203 and 206)

Polarity reversal is effected by interchanging the plate connection of VT2 and the cathode connection of VT1 in the high voltage circuit. In the schematic diagram, the crossed lines (+++) represent the connections for positive high voltage polarity, and the dashed (---) lines, the connections for negative high voltage polarity.

Switch SW2 is a double pole, double throw rotary snap switch that reverses the polarity of the output voltage indicating meter to correspond to the high voltage polarity.

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OPERATING INSTRUCTIONS:

1. - GROUND THE POWER SUPPLY BY MEANS OF BINDING POST PROVIDED FOR THIS PURPOSE, ON THE LEFT SIDE OF THE CABINET.

2. - Connect the line cord into a 117 volt 60 cycle outlet, and plug into the recessed receptacle on the lower left hand side. This simultaneously energizes the two-pronged outlet, which may then be used for any auxiliary equipment.

3. - Throw the toggle switch to ON. This energizes the rectifier filaments, and turns on the "FILAMENTS ON" pilot light. No warm-up time is needed, as the cathodes are directly heated.

4. - TURN THE COVAT* CONTROL TO ZERO. Depress the "HIGH VOLTAGE HOLD" pushbutton; this energizes the covat and turns on the "HIGH VOLTAGE" pilot light. Turn the covat control clockwise and read the output voltage on the appropriate meter.

When the "HIGH VOLTAGE HOLD" bushbutton is released, the high voltage transformer is automatically de-energized, and the output DC voltage will drop to zero. The rate of decay of the output voltage is determined by the load and meter resistances.

5. - To maintain high voltage without having to keep the "HIGH VOLTAGE HOLD" button depressed; proceed as in step (3). When the "HIGH VOLTAGE HOLD" button has been depressed, hold it in, and depress the "HIGH VOLTAGE LOCK" button. Both buttons may now be released, and the high voltage control manipulated to yield the desired output voltage.

6. - To de-energize the high voltage when the controls are locked in, depress the "HIGH VOLTAGE OFF" pushbutton.

7. - Throw the toggle switch to "OFF", after de-energizing the high voltage.

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MODELS 203 AND 206 ONLY

8. - POLARITY REVERSAL: Two wires, as shown heavily in the plan view of the Power Supply, must be properly placed for positive or negative high voltage. These two wires terminate in banana plugs, and are put into suitable jacks connected to ground and the high voltage capacitor C3b.

(a) POSITIVE HIGH VOLTAGE (negative ground):

The two wires must be connected as shown on the left, in the plan, rear view.

i.e. (1) From the plate cap of VT2 to the ground, or right, plug.
(2) From the cathode of VT1 to the output, or center, plug.

(b) NEGATIVE HIGH VOLTAGE (positive ground):

The two wires must be connected as shown on the right of the drawing.

i.e. (1) From the plate cap of VT2 to the output, or center, plug.
(2) From the cathode of VT1 to the ground, or right, plug.

9. - METER SWITCH: Set the polarity selecting switch on the control panel to either (+) or (-), as per the high voltage polarity.

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*See Note, Page 1

PRECAUTIONS:

1. - ALWAYS OPERATE WITH A GOOD EXTERNAL GROUND. For convenience, a terminal post connected to the case is provided at the lower left rear of the case. This precaution will prevent high voltage from appearing on the case unexpectedly.

2. - NEVER HANDLE THE OUTPUT LEAD WITH VOLTAGE ON. Although a protective resistor is included in the output circuit to limit the short circuit current to a harmless value, nevertheless, an extremely unpleasant shock may be experienced if contact is made with the exposed end of the output lead. It is suggested that the output clip be connected to the carrying handle after use of the Power Supply.

3. - TURN THE "HIGH VOLTAGE CONTROL" TO ZERO AFTER USE. This precaution will obviate the possibility of unexpected high voltage appearing in circuits, and possibly injuring equipment, when the Power Supply is again turned on.

4. - IF THE OUTPUT DOES NOT REACH 30 KV AT NO LOAD, check that the high voltage reversing leads are properly inserted for either positive or negative high voltage, as required.

5. - DO NOT DRAW MORE THAN 2 MA DC from the Power Supply, at ANY output voltage. The rectifiers are rated at 2MA DC maximum average current; drawing more current will shorten the life of the tubes noticeably. Since the rectifiers are connected in a full wave doubling circuit, each rectifier has the full average load current flowing through it, not 1/2 the load current, as in an ordinary full wave rectifier circuit.

6. - WITH LINE VOLTAGE LESS THAN 100 VOLTS, do not operate at voltages above 10 KV and currents above 1 MA simultaneously. The decreased rectifier heating voltage at low line voltage will result in excessive tube drop and deterioration of the cathode. At light loads, less than 250 microamperes, the output voltage may be 30 KV with 100 volts input.

7. - DO NOT OPERATE WITH LINE VOLTAGE MORE THAN 130 VOLTS, for extended periods, as the rectifier life will be shortened noticeably.

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APPLICATION NOTES:

1. - FUSING FOR CONTINUOUS OPERATION WITH FIXED LOAD:

If the Power Supply is to operate for a long period of time with fixed load, then it is recommended that the 2 ampere fuse normally provided with the Power Supply be replaced by one of smaller rating. This rating should be equal to the fixed load of approximately 1/4 ampere (due to the pilot lights, covat* exciting current and relay

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*See Note, Page 1

coil current) plus the transformed value of the covat* secondary current as read on the covat output current meter.

This precaution will assure rapid blowing of the protective fuse in case of partial or total failure of some component in the high voltage circuit, or shorting of the load. If the supply is overfused, a partial failure of a component or a load short may not blow the fuse, and operation under the partial overload condition may result in consequent burnout of a tube or resistor, or shorting of the doubler capacitor. Because of possible starting surges, it is suggested that a "Slo-blo" fuse be used, for this application.

2. - REMOTE OPERATION:

To operate the Power Supply at a distance from the control panel, remove the panel from the cabinet by unscrewing the six self-tapping holding screws on the panel. (The line cord should be unplugged). Pry apart the cable connectors that connect the components on the panel to the components in the cabinet proper. Mount the panel as required in the new control position.

Wire up a cable of suitable length with a male cable connector at one end, and a female at the other, corresponding to the type used in the Power Supply. The maximum length of the cable permissible is determined by the acceptable additional regulation due to line drop. Since the maximum line load is approximately 1.5 amperes, a typical multiconductor cable of 7 conductors, with #20 wire, will result in less than 10% additional regulation for a length of 300 feet.

The panel is connected to the cabinet by means of a common grounding wire in the cable. Therefore, if the cabinet is properly grounded, then the panel need not be grounded separately. However, taking the additional precaution of separately grounding ALL exposed metal surface not mechanically bonded, is very good practice when working with high voltages.

3. - SAFETY INTERLOCK:

Where the Power Supply is being used in conjunction with a high voltage test jig, it is frequently desired to interlock the jig cover and Power Supply, so that the high voltage cannot be applied unless the jig cover is closed. The auxiliary outlet S2 can be readily adopted for external interlocking purposes.

Thus, referring to Fig. 1, if S2 is disconnected from S1 and placed in series with the short strip of wire running from PB2 to the HIGH VOLTAGE ON pilot light PL2, the relay will be energized if PB2 is depressed, but PL2 will not be energized, and the covat* will not be energized, unless an external short is placed across S2. This short can consist of a microswitch actuated by closing the cover of the

*See Note, Page 1

test jig.

To effect the change: (Refer to the accompanying detailed wiring diagram)

(a) Remove the front and rear panels.
(b) Loosen the four screws that hold the filament transformer.
(c) Remove completely the two jumpers running from S1 to S2.
(d) Loosen the two cable connector covers, and run wires from the lugs of S2 to pins (8) and (9) on the female cable connector.
(e) On the control panel, disconnect the two ends of the wire coded with "Quik-Label" #8. This wire runs from a lug on PB3, the HIGH VOLTAGE LOCK pushbutton, to a lug on PL2, the HIGH VOLTAGE ON pilot light. Tape up loose ends.
(f) Run a wire from pin (8) on the male cable connector to that lug on PB3 from which wire #8 was removed.
(g) Run a wire from pin (9) on the male cable connector to that lug on PL2 from which wire #8 was removed.
(h) Screw the filament transformer back into place; replace the cable connector covers and plug in the two connectors. Replace the control panel and the rear panel.

S2 has now been wired in series with the parallel combination of HIGH VOLTAGE ON pilot light PL2 and the covat primary. Unless S2 is shorted, PL2 will not shine when PB2 is depressed.

This arrangement of S2 permits the relay R1 to remain actuated when the interlock is open. Thus, once the high voltage has been locked in, the output will be controlled by the jig interlock. When the sample under test is put in place, and the jig cover closed, the high voltage will come on automatically when the jig cover closes the microswitch (or other interlocking switch). The high voltage is automatically removed (though not shorted) when the jig cover is opened.

It should be recognized that this method of testing is somewhat hazardous is no automatic output shorting is used. The natural decay rate of the output voltage has a time constant of approximately 1 second. Thus, after 2 seconds, the output voltage is still about 10% of the initial voltage. If the initial voltage is above 15 KV, the residual charge is sufficient to produce a noticeable, though very mild, shock. With no external capacitance, the power supply is essentially fully discharged after 6 seconds maximum.

* *

If it is desired to "unlock" the high voltage if the external interlock is opened, then follow Steps (a) through (d) listed above; but, in Step (e) remove the wire with the Code #4. This wire goes from PB2, the HIGH VOLTAGE HOLD pushbutton to PB1, the HIGH VOLTAGE OFF pushbutton. In Step (a) run the wire to PB2; in step (g), to PB1.

With this connection, the interlock is in series with the push-buttons PB2 and PB1 and unless the external interlock is closed, no power can be applied to the relay or the high voltage circuits. And, if the relay has previously been "locked in," opening a jig cover interlock will automatically cause the relay to drop out, requiring deliberate resetting of the two pushbuttons PB2 and PB3 with the interlock closed.

4. - AUTOMATIC OUTPUT SHORTING:

S2 can be used to energize an automatic output voltage shorting mechanism. Thus, if S2 were connected in parallel with PL2, line voltage would appear at S2 when high voltage is on, and would be removed when high voltage is off.

This power could actuate a solenoid that removes a short from the output. When the power is removed from the solenoid, the solenoid plunger dropping out can short the output, bringing the high voltage DC inside the power supply and across the test specimen, rapidly to zero.

To connect S2 for such operation, it is merely necessary to move the lead, shown in Fig. 1 as going from the bottom of S2 to the top of S1, to the upper side of the covat* or PL2. To effect this change: (refer to the accompanying detailed wiring diagram)

(a) Remove completely the jumper going from S2 to that lug on S1 with the code wire #1.
(b) Run a wire from the now vacant lug on S2 to pin (8) of the female cable connector.
(c) Run a wire from pin (8) of the male cable connector to that lug on the HIGH VOLTAGE ON pilot light PL2 that has the wire with code #8.

Now, when the primary of the covat is energized, S2 will also be energized with line voltage. Thus, power is available to operate a solenoid or other mechanism that automatically shorts out high voltage when the HIGH VOLTAGE OFF pushbutton, PB1, is depressed, or when PB2, the HIGH VOLTAGE HOLD pushbutton, is released.

5. - KILOVOLTMETER ACCURACY

The initial accuracy of the kilovoltmeter is better than 2.5% of full scale over the entire kilovoltmeter range. The kilovoltmeter multiplier has an inherent temperature coefficient that will cause a drift of indication equal to approximately 1.5 KV, if the output is maintained at 30 KV continuously.

At output voltages below 24 KV, the heating effect on the multiplier is almost negligible. Therefore, at voltages below 24 KV the output kilovoltmeter indication may be taken as quite accurate. For close readings above 24 KV, if the power supply is operated continuously at the high voltage, a more accurate kilovoltmeter, such as the Beta Electric Corp. Model 102, should be connected across the output. An alternative is to apply a correction of approximately 1.5 KV to the reading at 30 KV. The power supply kilovoltmeter will read high.

*See note, page 1

REVISED: 9/21/51

E:
10 PIN JONES CONNECTOR.
m - MALE, f - FEMALE.
NUMBER CORRESPONDS TO PIN NUMBER ON CONNECTOR.

SCHEMATIC [illegible] FOR MODELS 202, 205 [illegible] PORTABLE POWER SUPPLY	
DIMENSIONS IN INCHES DO NOT SCALE	BETA ELECTRONICS CO. NEW YORK 29, N. Y.
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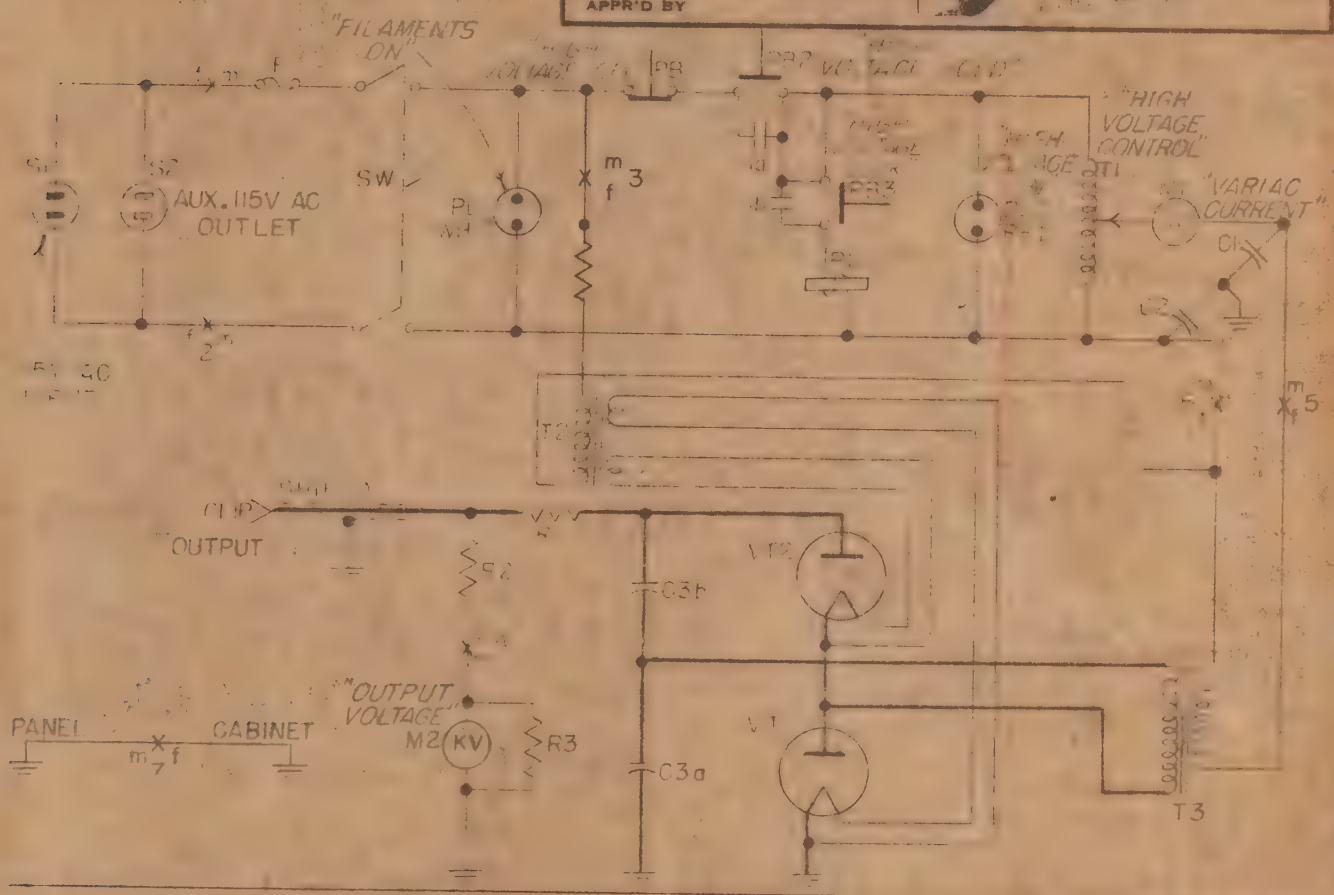

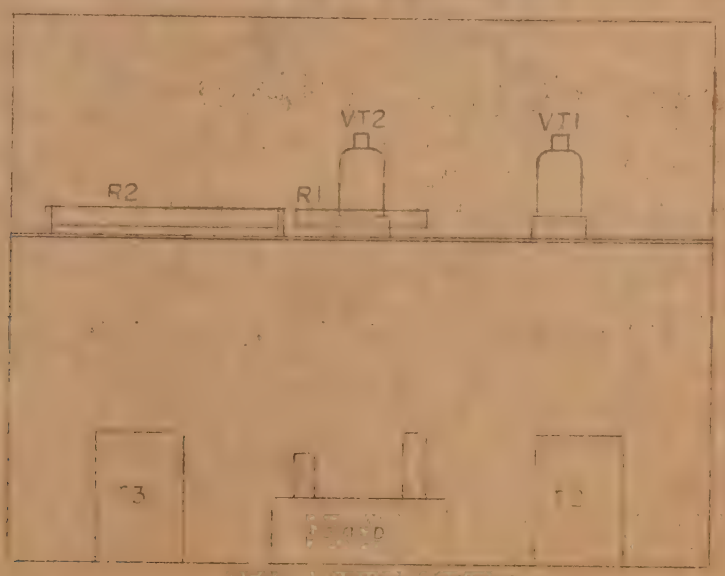

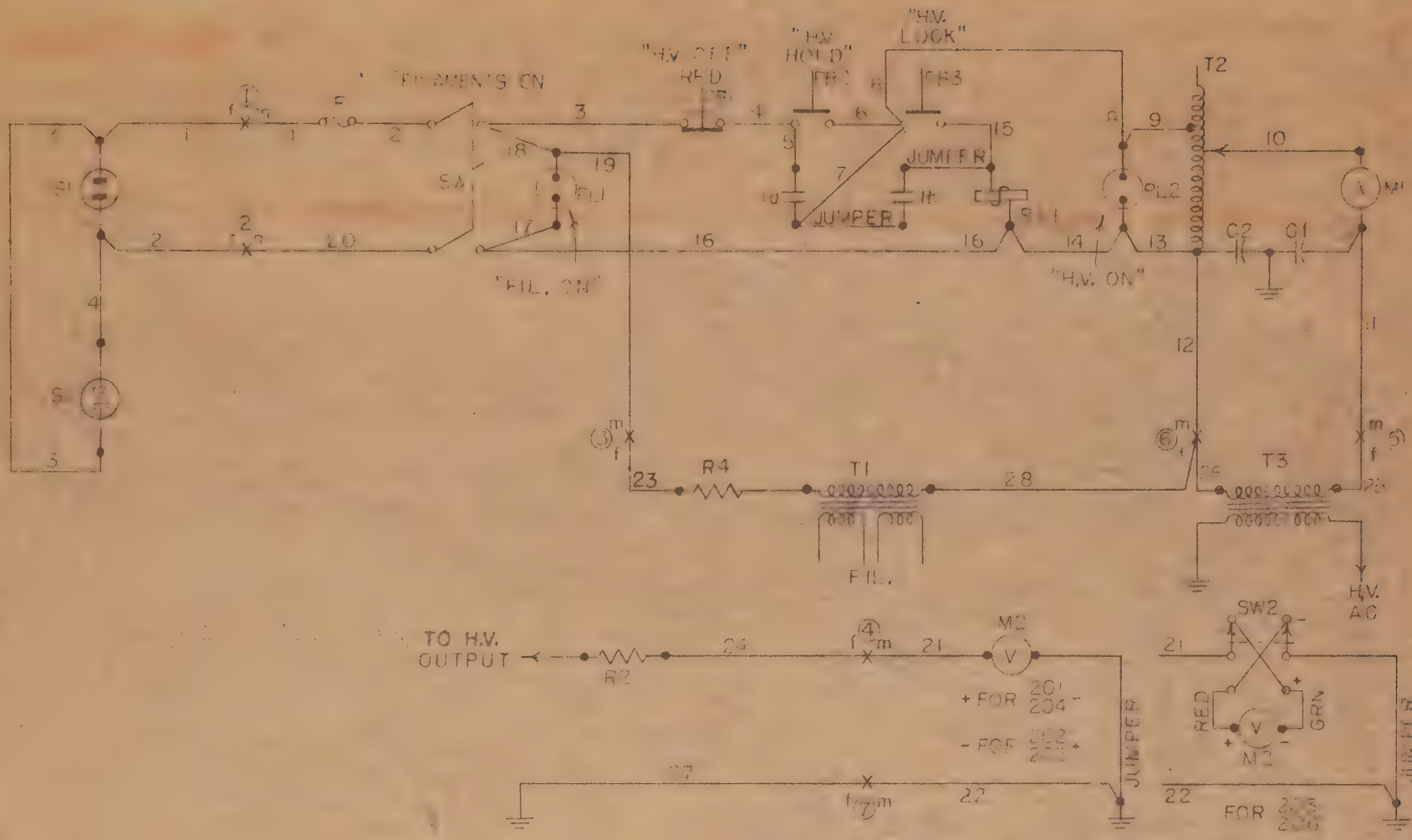

NOTE:
NUMBERS REPRESENT "QUIK LABEL" NUMBERS AT EACH END OF ACTUAL WIRE.

X —10-PIN JONES CONNECTOR m MALE f FEMALE
NUMBER REPRESENTS PIN NUMBER ON PLUG.

DETAILED WIRING DIAGRAM - CONTROL CIRCUIT	
DIMENSIONS IN INCHES DO NOT SCALE	BETA ELECTRONICS CO. NEW YORK 29, N. Y.
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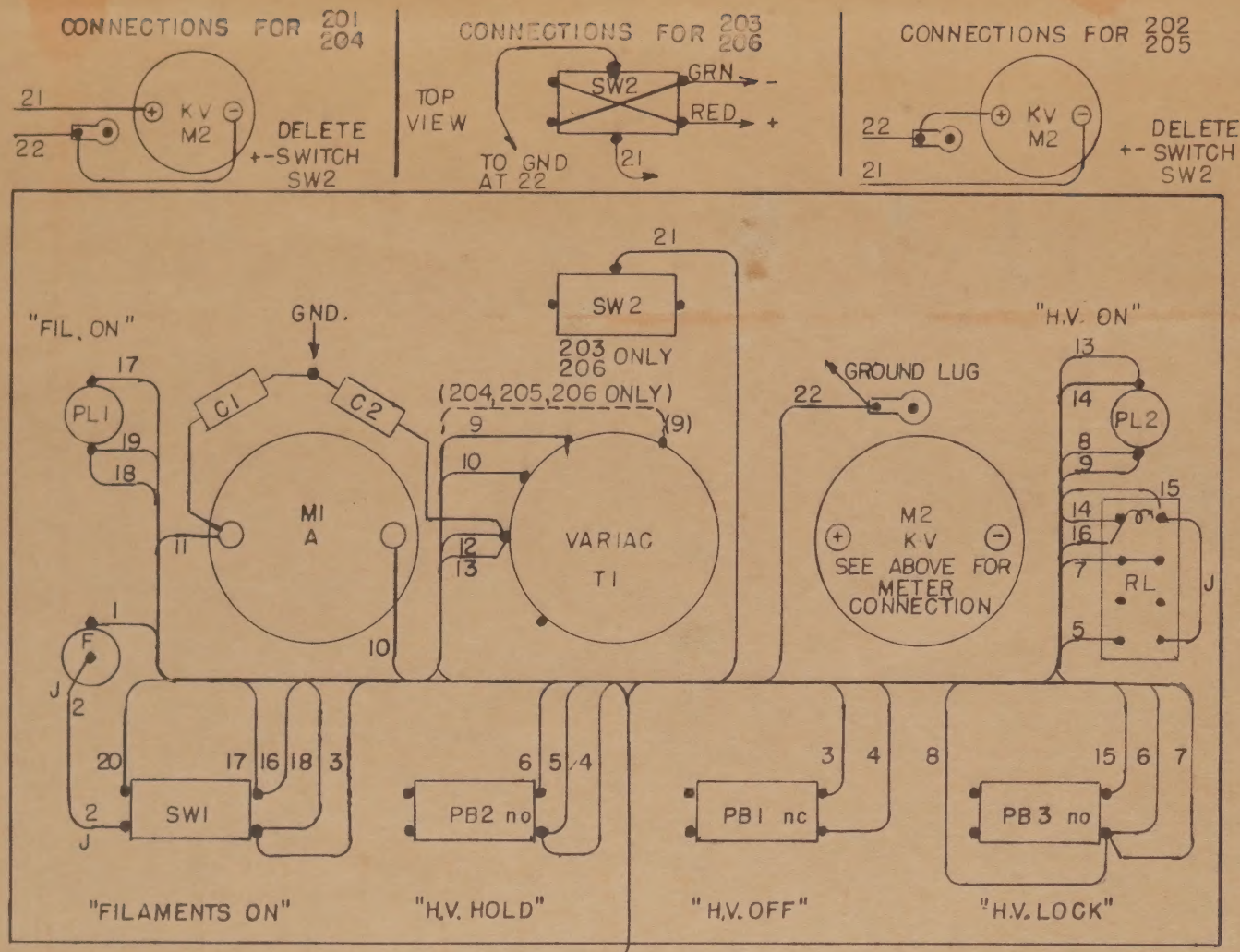
REVISION 5/2/51

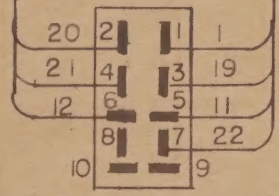


NOTE:

WIRING SHOWN FOR 203, 206

FOR 201, 204, 202, 205, DELETE REVERSING SWITCH AND WIRE KV METER AS SHOWN IN UPPER RIGHT AND LEFT HAND CORNERS.

J - JUMPER



10 PIN JONES PLUG MALE

DETAILED WIRING DIAGRAM CONTROL PANEL	
DIMENSIONS IN INCHES DO NOT SCALE	BETA ELECTRONICS CO. NEW YORK 29, N. Y.
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APPR'D BY	

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